

WE CLAIM:

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1. A force generating apparatus for providing a force to a moving element based upon receipt of an electrical force signal, the force generating apparatus comprising:

5 a force applying element defining a hydraulic cylinder and including a force applying piston within the cylinder coupled to the moving element for applying force to the moving element in response to increasing or decreasing fluid pressure within the cylinder;

10 an actuator defining an apply chamber and further including an actuator piston within the apply chamber, the actuator piston being operatively coupled to an actuator piston drive element for selectively increasing and decreasing a fluid pressure in the apply chamber, the apply chamber being fluidically coupled to the cylinder and force applying piston of the force applying element for actuation thereof by selectively
15 increasing and decreasing chamber pressure of the fluid in the apply chamber and communicating the increased or decreased chamber pressure to the cylinder in response to receiving the electrical force signal; and,

a controller for determining when the force applying apparatus is in a fast mode release, and modifying the value of the electrical force signal sent to the actuator to
20 limit the rate at which chamber pressure in the apply chamber is reduced during the fast mode release.

2. The force generating apparatus according to claim 1 wherein the force applying element comprises a caliper and a rotor.

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3. The force generating apparatus according to claim 1 wherein the force applying element comprises a shoe and a drum.

5 4. The force generating apparatus according to claim 1 wherein the actuator piston drive element of the actuator includes a motor responsive to the electrical force signal and a gear-ball screw assembly operatively coupling the actuator to the motor.

10 5. The force generating apparatus according to claim 1 further including a solenoid between the apply chamber and the force applying element for selectively isolating and connecting the force applying element from the fluid pressure in the apply chamber.

15 6. The force generating apparatus according to claim 1 wherein the controller is adapted for receiving a desired force signal and includes means for determining operation in fast mode release by:

determining a desired pressure in the hydraulic cylinder from the desired force signal;

20 determining a chamber pressure in the actuator chamber;
calculating a chamber pressure error by subtracting the desired pressure from the chamber pressure; and

comparing the chamber pressure error to a predetermined value of FMR Delta Pressure indicating fast mode release operation.

- 22 -

- 23 -

7. The force generating apparatus according to claim 6 wherein the controller further includes means for determining the predetermined value of FMR DELTA PRESSURE as a function of desired pressure.

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8. The force generating apparatus according to claim 7 wherein the means for determining the predetermined value as a function of desired pressure includes means for defining a first and a second value of FMR DELTA PRESSURE corresponding respectively to a first range and a second range of fast mode release operation as a

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9. The force generating apparatus according to claim 6 further comprising: a transducer coupled to the chamber of the actuator for sensing the chamber pressure and further coupled to the controller for delivering a chamber pressure

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10. The force generating apparatus according to claim 6 further comprising: means for enabling FMR when the chamber pressure error is less than an entrance value of FMR DELTA PRESSURE, and for disabling FMR when the chamber pressure error is greater than an exit value of FMR DELTA PRESSURE.

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11. The force generating apparatus according to claim 6 further comprising: means for modifying the electrical force signal by reducing the value of the electrical force signal during fast mode release.

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12. The force generating apparatus according to claim 6 further comprising means for applying the electrical force signal without modification when not operating in fast mode release.

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13. The force generating apparatus according to claim 1 including means for storing the modified value of the electrical force signal in the controller.

10 14. A method for modifying the electrical force signal to an actuator of a force generating apparatus, the force generating apparatus having a force applying element defining a hydraulic cylinder and including a force applying piston within the cylinder coupled to the moving element for applying the force to the moving element in response to increasing or decreasing fluid pressure within the cylinder, the force generating apparatus also having an actuator defining an apply chamber and further including an
15 actuator piston within the apply chamber coupled to an actuator piston drive element for selectively increasing and decreasing a fluid pressure in the apply chamber, the apply chamber being fluidically coupled to the cylinder and force applying piston of the force applying element for actuation thereof by selectively increasing and decreasing fluid pressure in the apply chamber and cylinder in response to receiving the electrical force
20 signal from a controller, the method including the steps of:

receiving a desired force actuation signal at the controller;
determining when the force generating apparatus is in a fast mode release;
modifying the electrical force signal to limit the rate at which fluid
pressure in the apply chamber is reduced during the fast release mode; and
25 sending the modified electrical force signal to the actuator.

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15. The method according to claim 14 wherein determining when the force generating apparatus is in a fast mode release comprises:
- 5 determining the desired pressure from the desired force actuation signal;
 determining an FMR DELTA PRESSURE value from a schedule of FMR
DELTA PRESSURE values as a function of desired pressure;
 determining chamber pressure in the actuator apply chamber;
 calculating a chamber pressure error by subtracting the desired pressure
10 from the chamber pressure; and
 comparing the chamber pressure error to the FMR DELTA PRESSURE
value for determining if the desired force signal will result in fast mode release operation.
16. The method according to claim 15 wherein the force generating apparatus
15 further includes a transducer coupled to the chamber of the actuator for sensing the
chamber pressure and further coupled to the controller for delivering a chamber pressure
signal to the controller.
17. The method according to claim 15 further comprising:
 enabling FMR when the chamber pressure error is less than an entrance
20 value of FMR DELTA PRESSURE, and disabling FMR when the chamber pressure error
is greater than an exit value of FMR DELTA PRESSURE.
18. The method according to claim 14 wherein modifying the electrical force
25 signal comprises reducing the value of the electrical force signal during fast mode release.

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19. The method according to claim 14 further comprising:
applying the electrical force signal without modification when not
operating in fast mode release.

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20. The method according to claim 14 further including storing the modified
value of the electrical force signal in the controller.

- 26 -